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(54) Title: A METHOD AND AN APPARATUS FOR CELL PLANNING
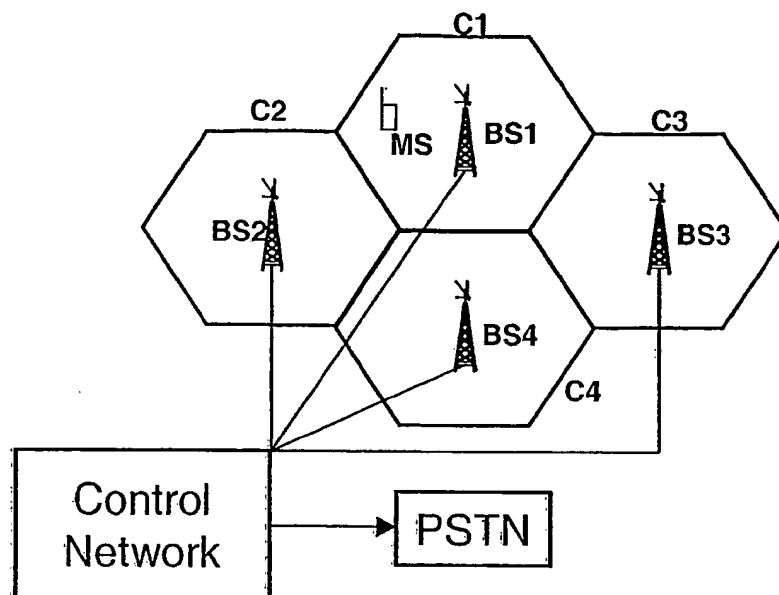
(57) Abstract: Measuring in a cellular telecommunication system the position of active mobile stations and the service, in terms of bit rate, they use. The first figure shows a number of users, four black dots having a voice connection with low bit rate and two users O having packet switched connection with a much higher bit rate. In the second figure the bit rate used is taken into consideration and, as shown by the greater area of the packet switched users, a more true picture of the traffic density is created. If the cell tends to get overloaded, requiring a cell split, the site X of a new base station will be shifted to the right comparing the second figure with the first.

FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii)) for the following designations AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW, ARIPO patent (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ,*

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— *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii)) for the following designation US*

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Published:

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A METHOD AND AN APPARATUS FOR CELL PLANNING

Technical field

The invention relates to bandwidth related cell planning in a mobile telecommunication
system.

Background

When building a cellular system the first thing to focus on is to have sufficient number of
base stations to create the wanted coverage area. When the intended area is covered and the
traffic starts to grow the system has to be expanded in capacity. The first step in doing this is
to add more transceiver units (TRUs) to the existing base stations and to re-use the
frequencies in the system as tight as possible. Due to the fact that the frequency spectrum
allowed to be used by each operator is limited, this adding of TRUs can only meet the
increased capacity demand to a certain extent. In the longer run congestion in the system will
occur and the perceived quality in the system will be too low. Then new smaller sites have to
be built to take care of the increasing capacity; i.e. a so-called cell split is needed.

Now the question arises where to build the new site. Of course it shall be built as close as
possible to where the traffic is generated in order to efficiently "off-load" the congested cells.
Building the cell there will also give a system with higher quality since the calls will
experience higher possible signal strength enabling enough margins to possible interfering
calls. Collecting the position from different mobiles using position methods available in a
mobile system e.g. cell ID/TA and E-OTD based on GPS and triangulation methods give the
operator a hint of where the calls are made in the systems. Using this information the operator
will have a decent view of where to build the new site. A method of determining traffic
density within cells for a similar purpose based on power level and geographic distribution of
the traffic is described in US 5 828 962 assigned to France Telecom.

In modern 2,5G &3G systems the users share resources from a common resource pool. In
addition different user-services consume more or less of these common resources. For
example in a WCDMA system the total power that can be transmitted in a cell is limited and a
subscriber using the 384 kbps packet data service will consume much more power than a
subscriber making a voice call, typically around 15 kbps or even less, from the same position.

If the 384 kbps user is close to the cell border almost all available power in the cell is needed to support that connection. But if the 384 kbps user is close to the site, thereby experiencing high signal strength, the power control algorithm will reduce the transmitted output power for this connection, which will free resources from the resource pool and make room for more users in the cell. This shows the necessity of locating the new site within an area, where many users of high bit-rate services, can be served as efficient as possible.

Summary of the invention

With this background in mind it is not sufficient to just use the positioning methods available

10   as of today to get to know where the most efficient new site position will be. Also information about which service that is used is needed. As an example it could be likely in a certain area that the high bit rate packet services are used in offices, while voice calls are more common in streets and open areas. In other areas there might be a different pattern all dependant on the users behaviour.

The solution is to combine information of where the connection is made together with the service used. By performing a measurement of this at regular intervals a statistical picture can be created. This information can then be stored and displayed to the operator to be used to refine the network in order to optimise its performance.

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It is thus an object of the invention to measure where the traffic is and the kind of traffic that is going on in the particular place.

Another object is to design a cell planning tool, which uses the measurement results to decide optimal sites for new base stations where such new sites are needed in order to avoid fatal congestion.

A further aspect of the invention is to use other parameters of the radio connection for the cell planning. One such parameter is the path loss of the channel allocated to the particular users.

30   This parameter is position related, but also related to the environment of the users – high buildings and narrow streets give a high path loss, while open areas like big squares and fields give much lower losses.

The objects and aspects of the invention are accomplished by a method of measuring the position related data of a mobile station together with information of type of services going on, a cell planning tool and a cellular telecommunication system all further defined in the appended claims.

Short description of the figures

Figure 1 shows an overview of a mobile telecommunication network in which the invention is used.

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Figure 2 and 3 illustrate the traffic distribution within a typical cell.

Figure 4 shows an example of implementation of the invention.

Figure 5 is a flow chart showing the collection of measurements according to the invention.

Description of preferred embodiments

In figure 1 a mobile communication network of typical design is shown. A control network is
20   connected to a number of base stations - four stations BS1-4 in the example - which base stations have radio connection with mobile stations – only one, MS, shown in the figure - within the various cells C1-4. The control network, e.g. the Base Station Controller, BSC, according to the GSM-standard or the Radio Network Controller, RNC, according to the WCDMA-standard, has communication with the fixed Public Switched Telephone Network, PSTN, and/or the Internet.

To get hold of the position for a mobile station a positioning order has to be sent to the mobile. The positioning method used is e.g. either the standardised OTDOA or A-GPS method or some other method well known in the art. The information about which service that is being used resides in the control network – or some other node of the system - is collected and stored together with the fetched positioning data. The position/service data can alternatively be sent directly from the mobile station to the network when so ordered. That requires that the mobile station knows all the relevant data. The combined service/position data is stored in a database in the control network or in another node.

When enough data have been collected a statistical picture of where different services are used can be displayed and used as input when deciding where a new site shall be built. This picture is the result when practising the invention and is used in order to build the new site in an optimal position. This will lead to a cost efficient way of cell planning. To refine the picture an optimising algorithm (e.g. least square root) could be used when calculating the most efficient new site position.

Figure 2 is an illustrative example of the position of a number of users within a cell. The
10   black dots marks users having an ordinary voice connection with a low bit rate while O marks users having another service such as packet switched data with much higher bit rate. In figure 3 the bit rate of the users is taken into account. The four small areas to the left in figure 3 mark voice connection with low bit rate. The two packet connection to the right get a much larger area corresponding to the much higher bit rate used. The two figures 2 and 3 shows the need to shift the placing of a new base station, marked X, to the right if not just the position, but also the service used is regarded.

In a further example the path loss is also taken into account. This is illustrated by figure 4 and the following table.

	Position (n)	Bit rate (kbps)	Path loss (dB)
20	1	12,2	130
	2	64	123
	3	12,2	123
	4	384	156
	5	384	100
	6	64	112
	7	384	133
	8	12,2	124
	9	384	140
30	10	12,2	135
	11	64	138

The table shows data from eleven users, position n = 1-11, in figure 4, used bit rates (BR) and the path loss (PL) in dB of their radio channels. The data from the users in the cell according to figure 4 are collected by the RNC/BSC and transferred to a cell planning system node, CPS. The CPS comprises data collecting and calculation equipment in order to perform predictions for potential new site positions using for example Monte Carlo analysis. The

optimal position (x_{opt}, y_{opt}) of a new site is where the maximal bit rate per path loss attenuation is found during the analysis. This is summarised by the following expression: -

$$x_{opt}, y_{opt} = max\ f(BR_n/PL_n,\ x_n,\ y_n)$$

for all mobile users n within the selected area, i.e. the cell of figure 4.

The found "new site" is indicated to the right in the figure, which is close to the users 9 and 4 using high bit rate and having a high path loss. The output from CPS may be regarded as a map for personnel building the new site

10   The flow chart of figure 5 describes a number of steps for practising the invention. Step 1 is to find the positions of the mobiles being in a more or less active mode using certain services within a particular cell. In step 2 the system registers the bit rate used by each mobile and optionally also the path losses of the radio channels used. Based on these data a picture of the traffic density is estimated in step 3 and if the cell tends to get congested or overloaded - step 4 - and if there are no other means to extend the capacity of the cell a decision YES is taken in step 5 to build a new base station – step 7 – in a place based on calculation made in step 6. As long as there is no need for cell split – decision NO of step 5 – step 1-4 are repeated at more or less regular intervals. The decision that a cell is overloaded can, of course, be taken on other grounds than the steps according to the flow chart. However, whenever there is a need

20   for a cell split the principles of the invention is used to find the new base station site.

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Claims

1. A method in a cellular mobile telecommunication system for cell planning where a cell tends to get congested or overloaded *characterised in* that position related data for mobile users (MS) is registered together with what service is used by each user in terms of bit rate and wherein an estimation of the traffic intensity within the cell is created.

2. The method of claim 1, wherein the position related data is the locations (x,y) of the mobiles and the path losses experienced on their radio channels (CH).

3. The method of claim 1 or 2, wherein an optimal site for a new base station is established based on the registered data.

4. The method of claim 3 wherein maximising the following function gives the optimal site (x_{opt}, y_{opt}) for the new base station

$x_{opt}, y_{opt} = max\ f(BR_n/PL_n, x_n, y_n)\ for\ all\ n$

where n an index number for the mobile users of the cell, BR_n is the bit rate used, PL_n is the path loss and x_n, y_n is the location of the user n.

5. The method of claim 4, wherein a map is created showing the site of the new base station.

6. A cell planning tool in a cellular telecommunication system comprising a control network (RNC/BSC) for registering position related data of mobile stations (MS) using the system *characterised in* that means are included for registering the services used by the mobile stations and of further means for, based on the positioning and service data, estimating the traffic density of the cell.

7. The cell planning tool of claim 6, wherein the tool further comprises means for registering the path losses of the radio channels (CH) allocated to the mobile users.

8. The cell planning tool of claim 6 or 7 wherein an optimal place (x_{opt}, y_{opt}) for a new site is established in a cell planning system node (CPS) of the tool.

9. The cell planning tool of claim 8, wherein the system node (CPS) establishes the optimal place (x_{opt}, y_{opt}) based on the maximum of the following expression

$$x_{opt}, y_{opt} = max\ f(BR_n/PL_n, x_n, y_n)\ for\ all\ n$$

where n an index number for the mobile users of the cell, BR is the bit rate used, PL is the path loss and x, y is the location of a user.

10
10. A cellular telecommunication system comprising base stations (BS) and mobile stations (MS) in communication with each other in a cell under supervision of a control network (RNC/BSC) *characterised by* a cell planning system node (CPS) which collects data from the telecommunication system relating to the location (x, y) of the mobile stations (MS), their path losses on their radio channels and the services they use, and wherein said node (CPS) comprises data collecting and calculation equipment, which predicts an optimal place (x_{opt}, y_{opt}) for a new base station when the cell otherwise will be overloaded.
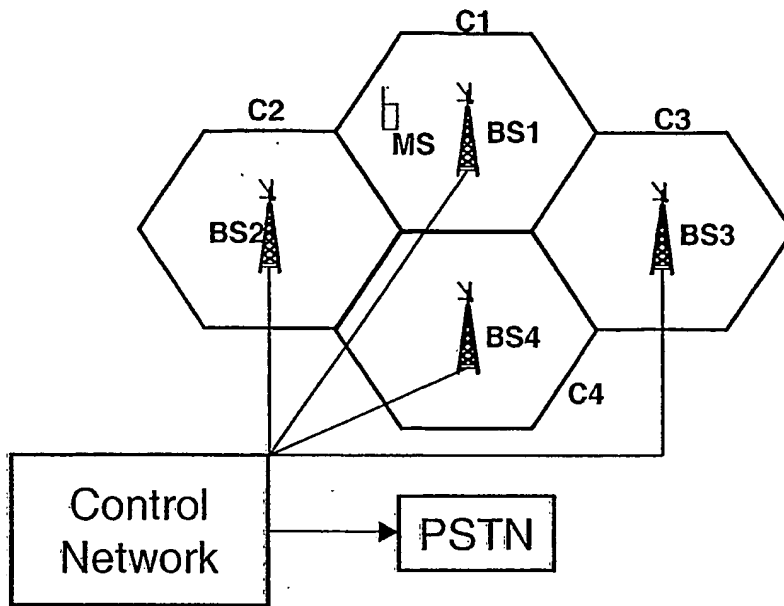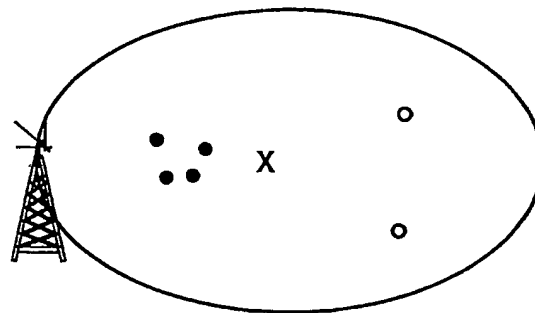
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Fig 1

Fig 2

Fig 3

Fig 4

3/3

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          ┌──────────────────────────────────────────┐
          ↓                                          │
  ╭───────────────────────────────────────╮         │
 ( 1     Register the position of mobiles   )        │
  ╰───────────────────────────────────────╯         │
          │                                          │
          ↓                                          │
  ╭───────────────────────────────────────╮         │
 ( 2          Register service used         )        │
  ╰───────────────────────────────────────╯         │
          │                                          │
          ↓                                          │
  ╭───────────────────────────────────────╮         │
 ( 3         Estimate traffic density       )        │
  ╰───────────────────────────────────────╯         │
          │                                          │
          ↓                                          │
  ╭───────────────────────────────────────╮         │
 ( 4    The cell tends to get overloaded?    )        │
  ╰───────────────────────────────────────╯         │
          │                                          │
          ↓                                          │
         ◇                                          │
        ╱ 5 ? ╲─────────────────────────────────────┘
        ╲     ╱              NO
         ◇
          │
        YES
          │
          ↓
  ╭───────────────────────────────────────╮
 ( 6    Calculate position for new site     )
  ╰───────────────────────────────────────╯
          │
          ↓
  ╭───────────────────────────────────────╮
 ( 7           Build new site               )
  ╰───────────────────────────────────────╯
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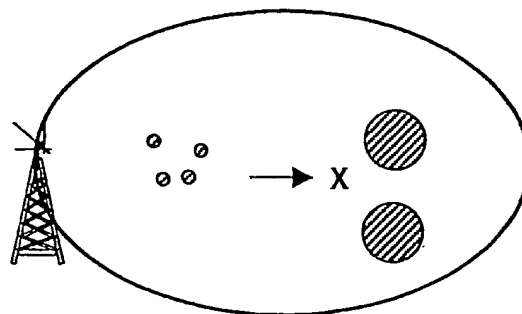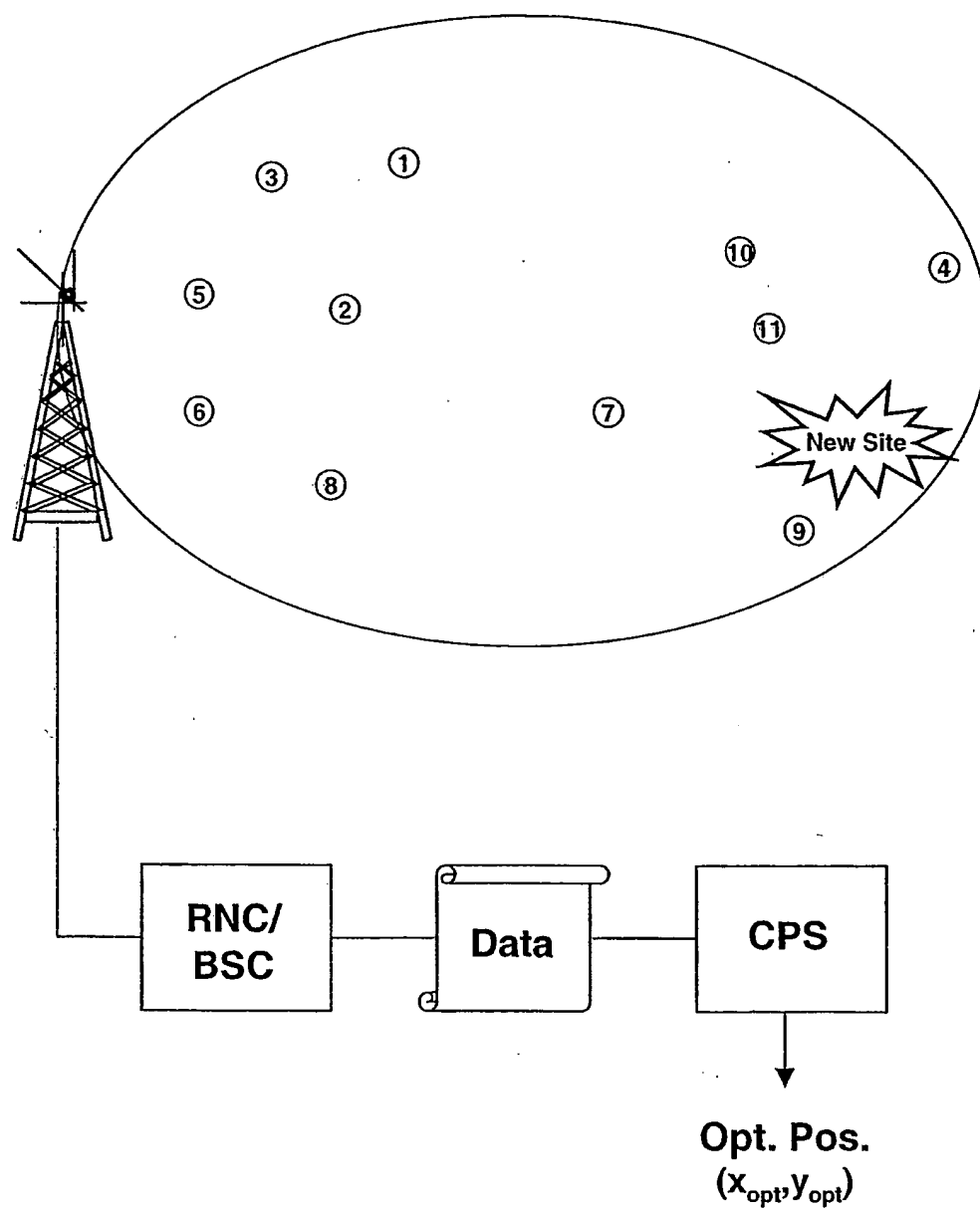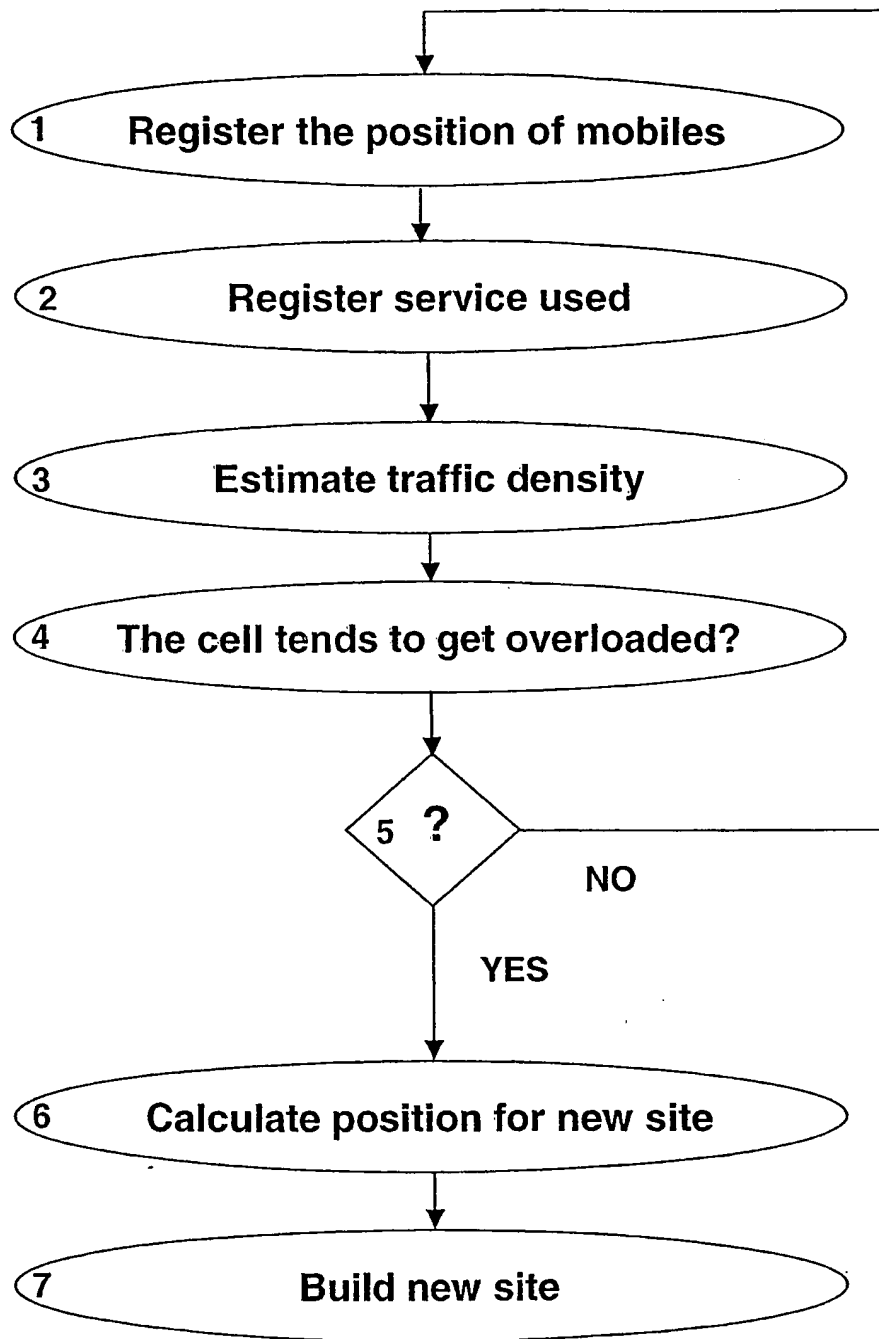
Fig 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 2004/000809

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04Q 7/36

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL,WPI DATA, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5561839 A (ÖSTERBERG, A ET AL), 1 October 1996 (01.10.1996), column 4, line 16 - line 49, figure 1, abstract	1-10
Y	IRONS, S ET AL: Supporting the successful deployment of third generation public cellular technologies-system dimensioning and network planning. In: 3G Mobile Communication Technologies, 2000. First Int Conf on (IEE Conf Publ No 471) Publ 27-29 March 2000, London, UK. On pages 156-160. Inspec AN: 6597953. See whole document	1-10

[X] Further documents are listed in the continuation of Box C.   [X] See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
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"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"O" document referring to an oral disclosure, use, exhibition or other means	
"P" document published prior to the international filing date but later than the priority date claimed	"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
13 August 2004	1 8 -08- 2004

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GARG, V K ET AL:A tool to calculate Erlang capacity of a BTS supporting 3G UMTS system. In: Personal Wireless Communications, 2000 IEEE Int Conf on, Publ 17-20 Dec 2000, Hyderabad, India. On pages 173-177. Inspec AN: 6970405. See pages 173,174,176 --	1-10
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